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RESEARCH ON MOLECULAR LASERS

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During this second quarterly period the frequency selective molecular laser was fitted with an echellette grating having larger angular dispersion so that operation on individual rotation-vibration transitions was reliably obtained for N_2O-N_2-He as well as for CO_2-N_2-He. As was already indicated in the first Quarterly Report, power output is in the 5-20 watt range over most of the P and R branch transitions (00°1-10°0) of CO_2. Individual oscillation on P-2 to P-44 inclusively and on R-0 to R-44 inclusively is obtained for the above transition in CO_2. This discreet spectrum is spread over a region of about 1.0 micron which is about 10% of the center wavelength.

Experiments have been performed to measure the gain of CO_2-N_2-He gas lasers on individual rotation-vibration transitions in the P and R branches of CO_2 around 10.6μm. The differential gain coefficient α, m^{-1} was measured on P-2 to P-44 inclusively and on R-0 to R-44 inclusively. Plots of our results are included with this report. The maximum on axis, small signal gain for our 1.06 meter long amplifier was 2.0 on the P-18 transition corresponding to α equal $0.65m^{-1}$. Both P and R branches showed peak gain for J=18 (lower level) indicating that the total inversion of 00°1 relative to 10°0 was greater than 1.1. We shall repeat these measurements with a frequency stabilized and acoustically isolated laser so as to obtain more precise gain measurements. These results will be used to determine the distribution of excited state population among the rotational levels and to determine the appropriate rotational temperatures if rotational thermal equilibrium is indeed found to exist.

Experiments were performed to measure the power level at which each rotation-vibration transition began to saturate in our 1.06 meter long amplifier tube. Data has been obtained but additional work at higher power levels remains to be done. Preliminary results indicate that at an input power level of 200 m watt in a 1/4

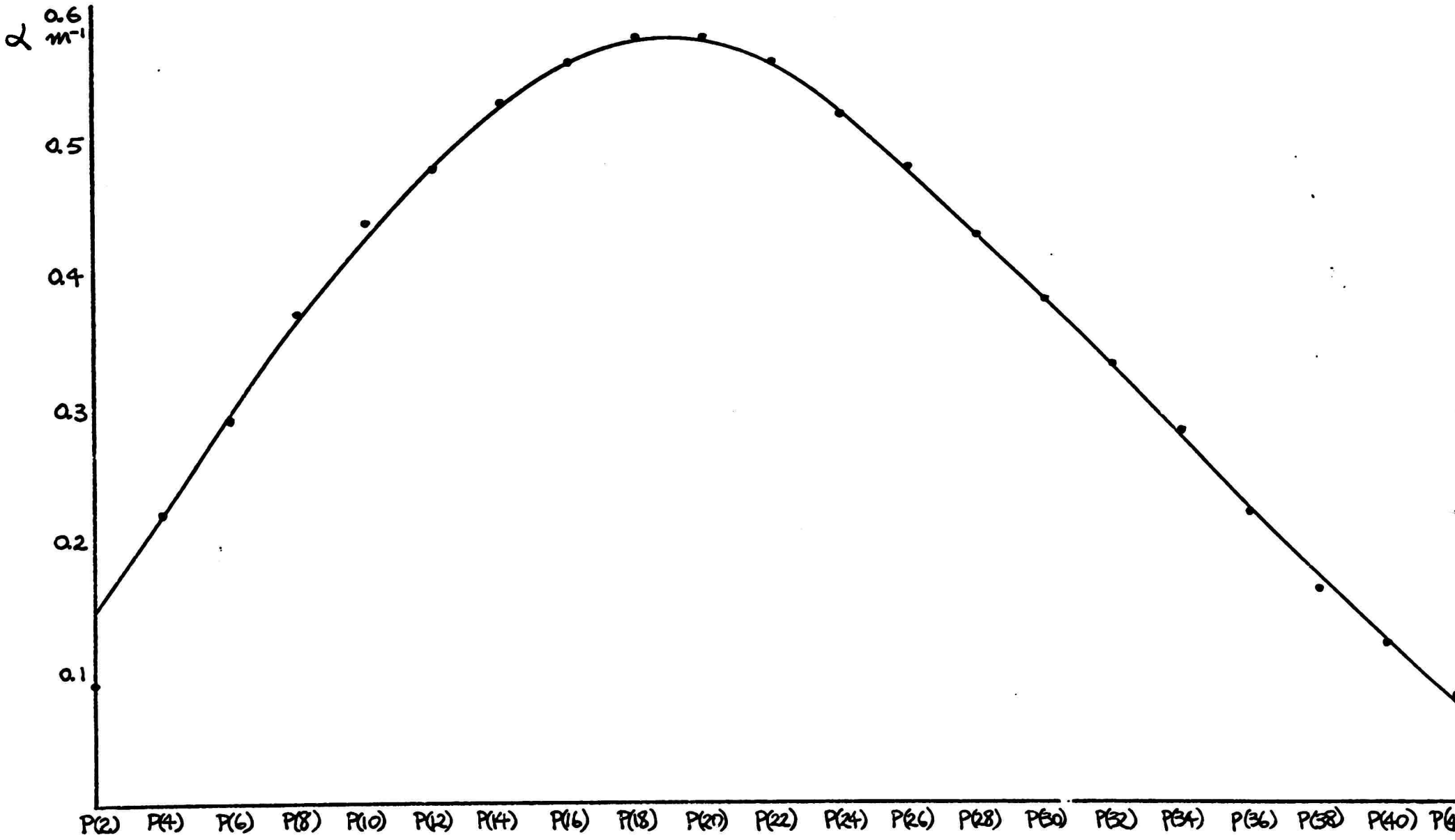
inch diameter beam the gain on P-18 deviated from linearity by 7.5% due to saturation in the 1.06 meter active length. A representative data plot is included with this report. Information concerning power saturation may be used in conjunction with variable operating conditions in the gas discharge to infer information concerning pumping and relaxation processes. In addition, the saturation properties of a single frequency CO_2 laser must be determined for successful prediction of saturated power output from an oscillator-amplifier system.

Considerable experience has been obtained concerning the characteristics of lasers operated with gratings as end mirrors. It has been found possible to use the grating as a variable coupling output mirror in such lasers in addition to its function as an internal wavelength selector.

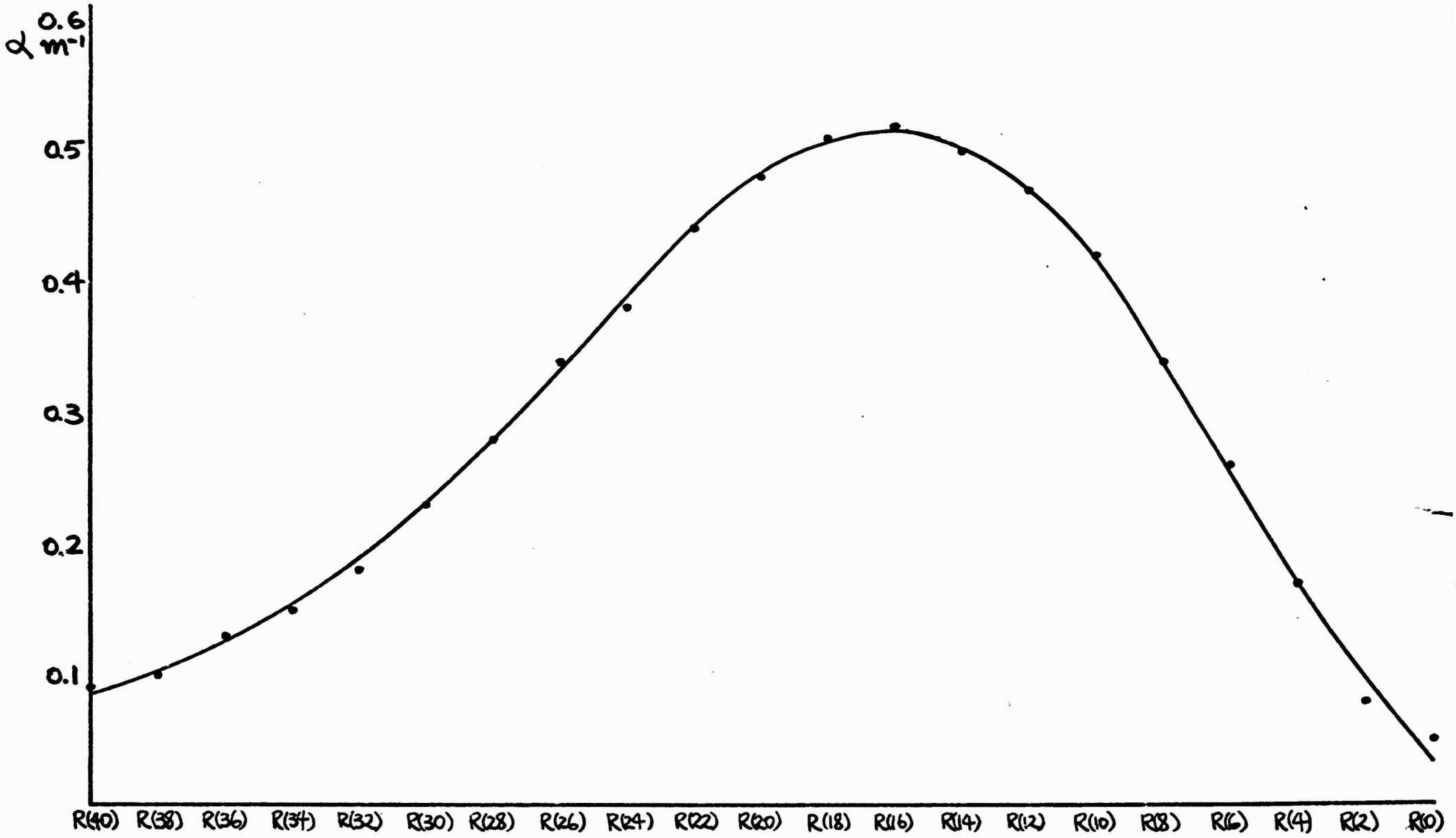
A stable CO_2-N_2-He laser is under construction for experiments to attempt to observe a Lamb dip under single axial mode, single frequency operation. Such experiments will be carried out during the next quarterly period.

Gain and saturation measurements on the N_2O-N_2-He molecular laser will commence during the next quarterly period.

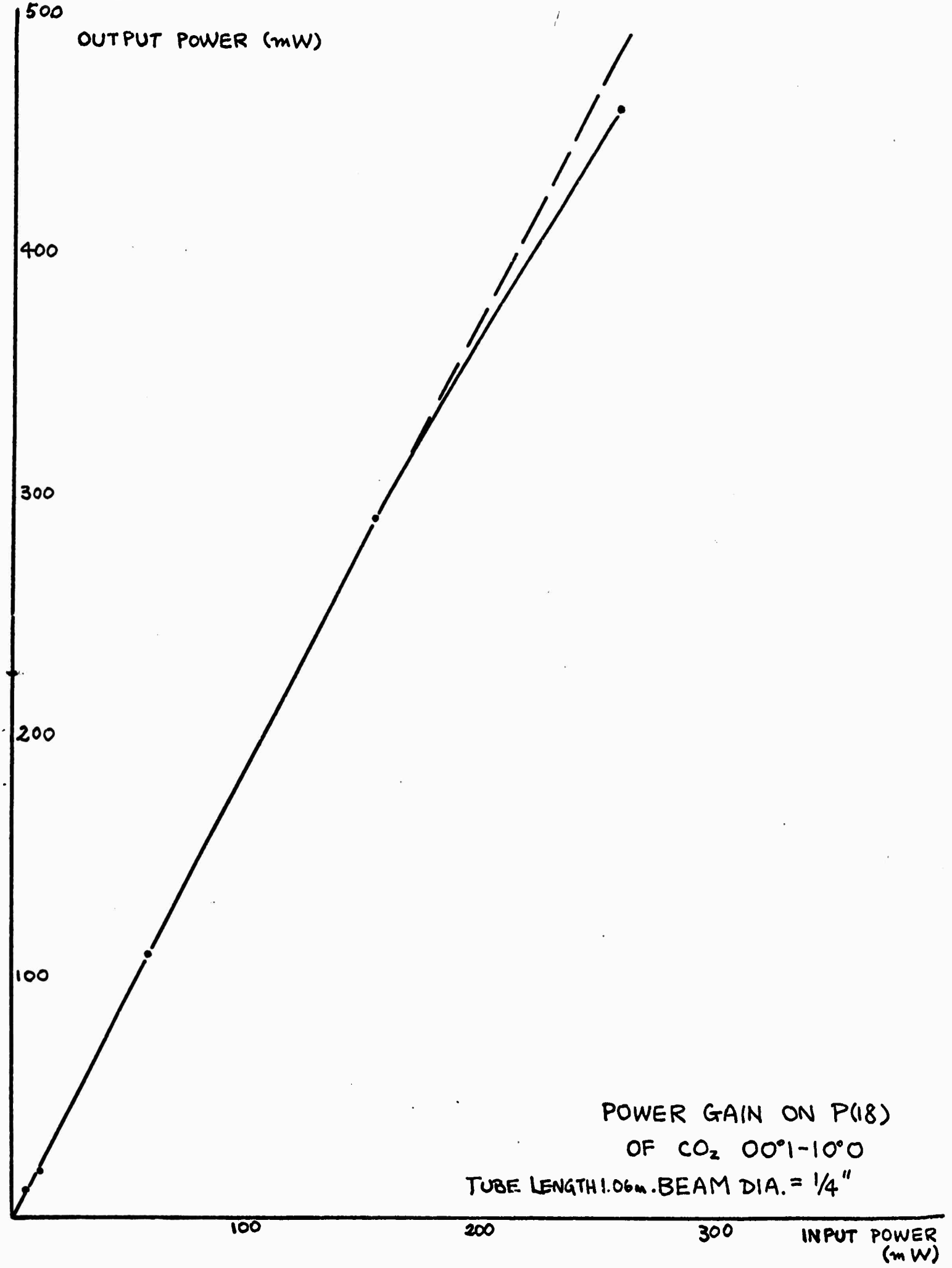
A Q-switch CO_2-N_2-He laser is under construction for the optical transient nutation experiment. This experiment is undertaken to obtain information concerning rotational relaxation times in the lasing states of CO_2.



OPTICAL GAIN COEFFICIENT FOR P-BRANCH TRANSITIONS IN CO_2 $00^0 1 - 10^0 0$



OPTICAL GAIN COEFFICIENT FOR R-BRANCH TRANSITIONS IN CO_2 00°1-10°0


500
OUTPUT POWER (mW)
400
300
200
100
100
200
300
INPUT POWER (mW)
POWER GAIN ON P(18)
OF CO_2 00°1-10°0
TUBE LENGTH 1.06m. BEAM DIA. = 1/4"

Unclassified

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13. ABSTRACT

Experiments which have been performed to measure the gain of CO_2-N_2-He gas lasers on individual rotation-vibration transitions in the P and R branches of CO_2 around 10.6μm. The differential gain coefficient α m^{-1} was measured on P-2 to P-44 inclusively and on R-0 to R-44 inclusively. Experiments were also performed to measure the power level at which each rotation-vibration transition begins to saturate in a 1.06 meter tube length. Preliminary analysis of data indicates that the inversion of 00°1 relative to 10°0 is greater than 1.1. At an input power level of 200 m watt in a 1/4 inch diameter beam the gain on P-18 deviates from linearity by 7.5% due to power saturation.

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